THE BOEING COMPANY
COMMERCIAL AIRPLANE DIVISION

737-100
GENERAL DESCRIPTION

C-135A
C-135B
KC-135A
C-135F
720
EC-135C
367-80
720B
RC-135B
707-138
RC-135A
707-120
707-120B
737
VC-137B
VC-137C
707-220
707-320C
707-320
707-320B
727C
707-420
727
BOEING
Jet Transport Family
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966

The 737 fills out Boeing's family of jetliners specifically designed to serve a variety of markets. In the mid-1950's the popular 707 concentrated on the continental market and longer routes with one stop. Later the 707-320 and -320B extended the nonstop range to 6000 miles. These long-range jetliners gradually displaced slower piston and turboprop airliners to shorter, less competitive routes. As displaced airplanes grew older Boeing's 720 and 727 jetliners were introduced on shorter and shorter routes.

Now the 737 offers the public jet speed, comfort, and convenience on routes as short as 100 miles. Fully certificated 737's scheduled for delivery beginning in late 1967 offer attractive profit potentials. Boeing jets have proved profitable in the past. The 737 will pay off in the future.

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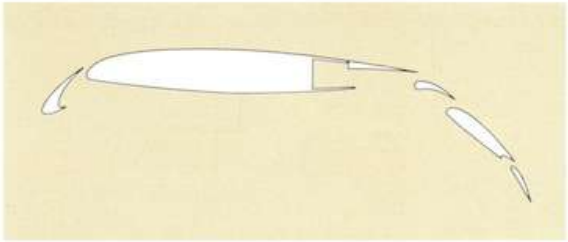
ECONOMICS 34



summary

Evolving naturally from its 707/720/727 predecessors, the 94 - foot long 737 with its 89 - foot wing span has a nominal design gross weight of 85,000 pounds and maximum weights as high as 93,500 pounds. The 737 is designed to operate over ranges from 50 to 1100 statute miles, at a cruise speed of Mach .82, from runways about 4800 feet long.

CABIN FLEXIBILITY

The 737 large diameter fuselage gives it a unique "intercontinental" 6-abreast seating capability and provides comfort levels in a 5-abreast configuration that are unattainable with other designs. The 737 double-lobe cross-section symbolizes Boeing's concern for passenger comfort and its desire to attain maximum flexibility of seating arrangements.

A generous 650 cubic feet of below deck cargo volume is achieved at no expense to window seat passenger space or aisle headroom. Passengers accustomed to earlier Boeing aircraft will find that the 737 continues the feel of the larger jets.

HIGH LIFT

Airplane designers have continued to fight the compromises necessary to accommodate higher and higher cruise speeds without increasing field lengths for takeoff and landing. Large area, cambered wings that reduce field lengths are uneconomical at cruise speeds near Mach .80 to .90. Boeing's advanced high-lift system, developed and proved on the 727, provides unmatched low-speed performance in a wing uncompromised at cruise. Essentially, the 737 uses two wings in one—a low-speed wing for operation on fields formerly used only by low-speed piston airplanes and a high-speed wing compatible with speeds near Mach .80.

The 737's high-lift system uses triple-slotted trailing-edge flaps, leading-edge slats outboard of the nacelles, and Krueger-type flaps along the wing between nacelles and the body. With the high-lift devices, the 737 can operate from airports as short as 4500 feet. Approach speeds of about 111 knots will facilitate the attainment of weather minimums as low as 50-foot ceilings and 700-foot visibility conditions. Short takeoff distance and low approach speeds also reduce ground and air maneuver times to improve productivity.

POWER PLANT

Two wing-mounted Pratt & Whitney JT8D engines give the 737 its power. Weighing 3096 pounds, each engine provides up to 14,000 pounds of takeoff thrust (SL Static) and a cruise thrust of 4685 pounds at 25,000 feet altitude. Specific fuel consumption is .803 pounds per hour per pound of thrust at 25,000 feet. (All standard day characteristics.) Specifically developed for the 727 airplane, the JT8D has achieved a TBO of 2400 hours with continued improvement in TBO expected with the 737.

Appearing low to the ground, the engine inlet has greater clearance than inboard 720B engines which have shown a minimum record of runway debris ingestion.

WHY WING-MOUNTED ENGINES?

Two teams of preliminary design engineers competed to find the most favorable engine location for the 737. This competition included a full series of wind tunnel tests on both wing- and tail-mounted designs. The clear winner—engines tucked close under the wing. The many advantages include:

- Intercontinental-width cabin and doors at each corner and a minimum of unusable space in the aft fuselage.
- Flexible Loadability. Passenger and cargo can be loaded fore and aft of the CG when engines are also near the CG.
- "Eye-level" engine accessibility and low tail for maintenance.
- Improved Structural Efficiency — Engines are carried where the lift is being generated to permit using heavy wing structure more efficiently and lightening and simplifying structure of body and tail. A total wing, body, and tail weight saving of 1500 pounds is achieved.

- Simplified Systems—Plumbing and controls are short and simple with air, hydraulic, and electrical power near system centers.
- Aerodynamic Efficiency—Wide body can be faired effectively as long as it is not hampered by tail engines. Low tail on aft body avoids troublesome pitch-up. Engines' "fence effect" ensures wing stability.

RELIABILITY AND SELF SUFFICIENCY

Proven dispatch reliability of the 727 (98 percent after only 8 months of operation) will be increased (target 99 percent) by simplification and redundancy. Self-contained airstair, APU, and high landing weight will maximize thru-stop efficiency.

COMMONNESS

One design team for the 727 and 737 assures a high degree of commonness. This commonness assures: 1. reduced spares inventory 2. reduced maintenance training 3. fewer ground service equipment items and 4. reduced flight crew training.

MAINTAINABILITY

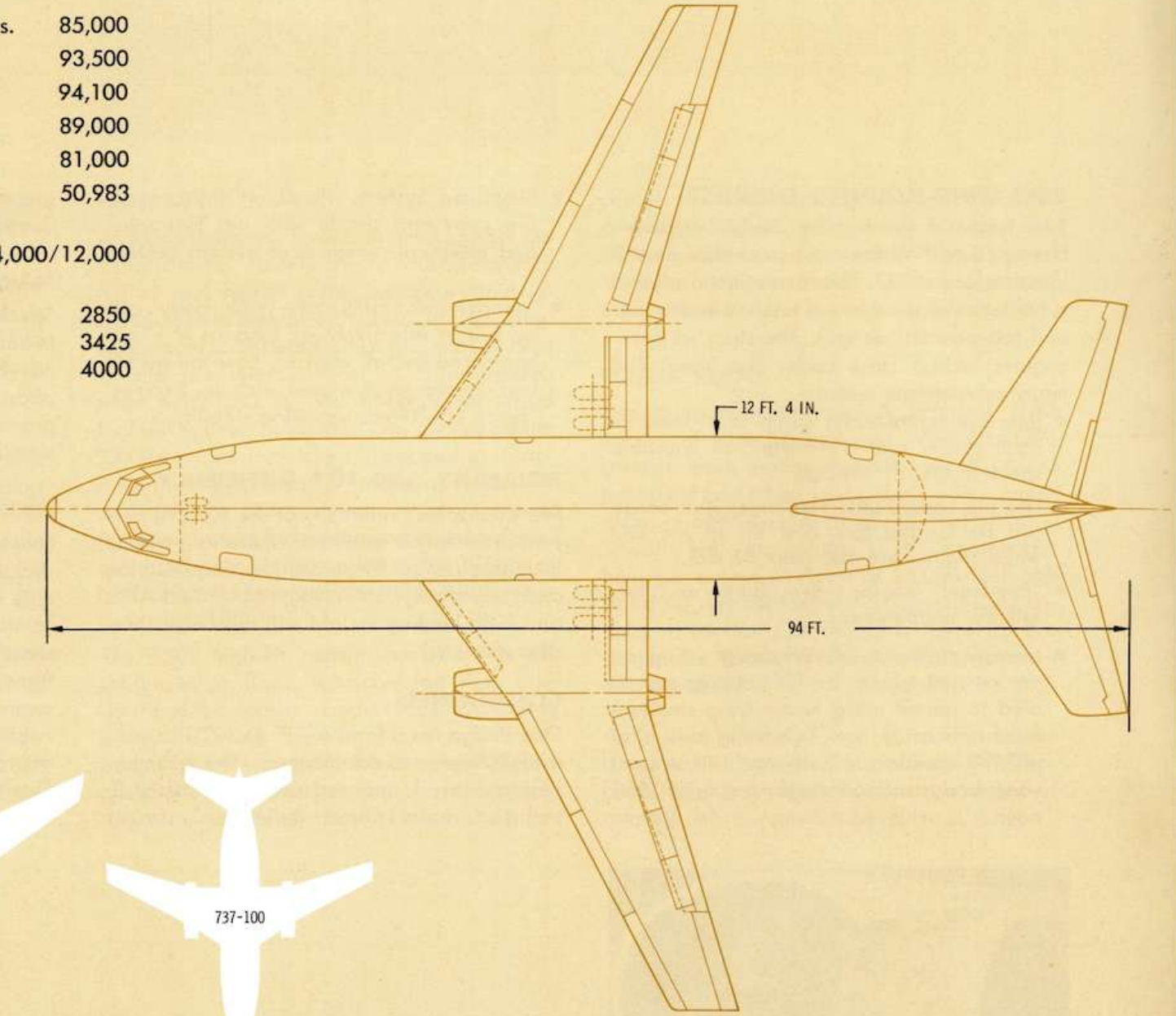
Special attention has been given on the 737 toward reduction of maintenance costs. This has been achieved by placing special emphasis on: 1. reliability 2. commonness of proven components 3. accessibility and 4. simplicity.

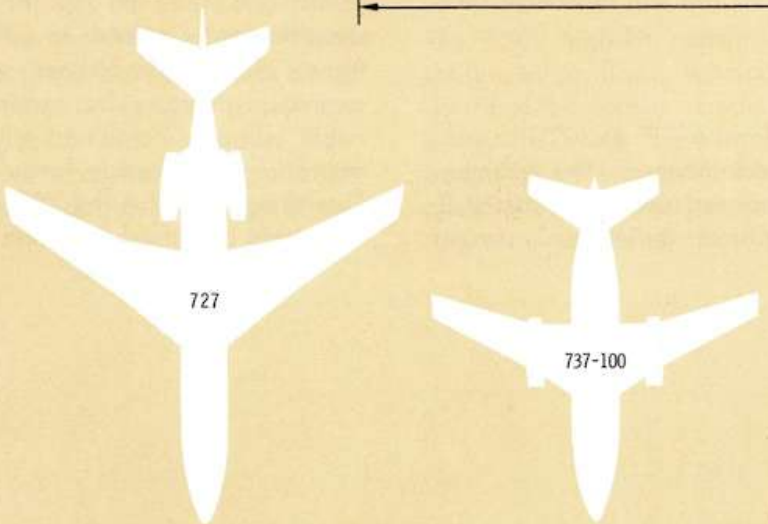
ECONOMICS

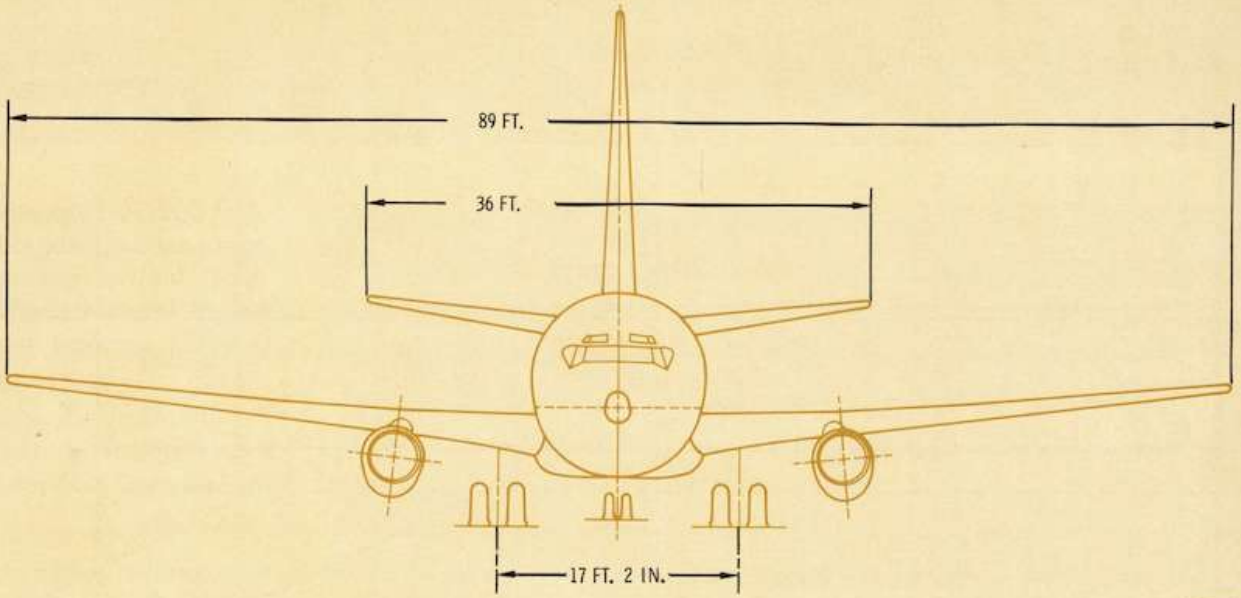
Low initial cost, airplane-mile costs under one dollar, and 6-abreast seating to reduce seat-mile costs to less than one cent per seat-mile combine to make the 737 the most profitable short haul jet available to airlines. Exact cost figures depend on airlines' specific analyses and route structure, but seating flexibility and cabin capacity combined with low airplane operation cost provide large profit potential. Operating costs for the 737 at short ranges are about one third less than for the 727.

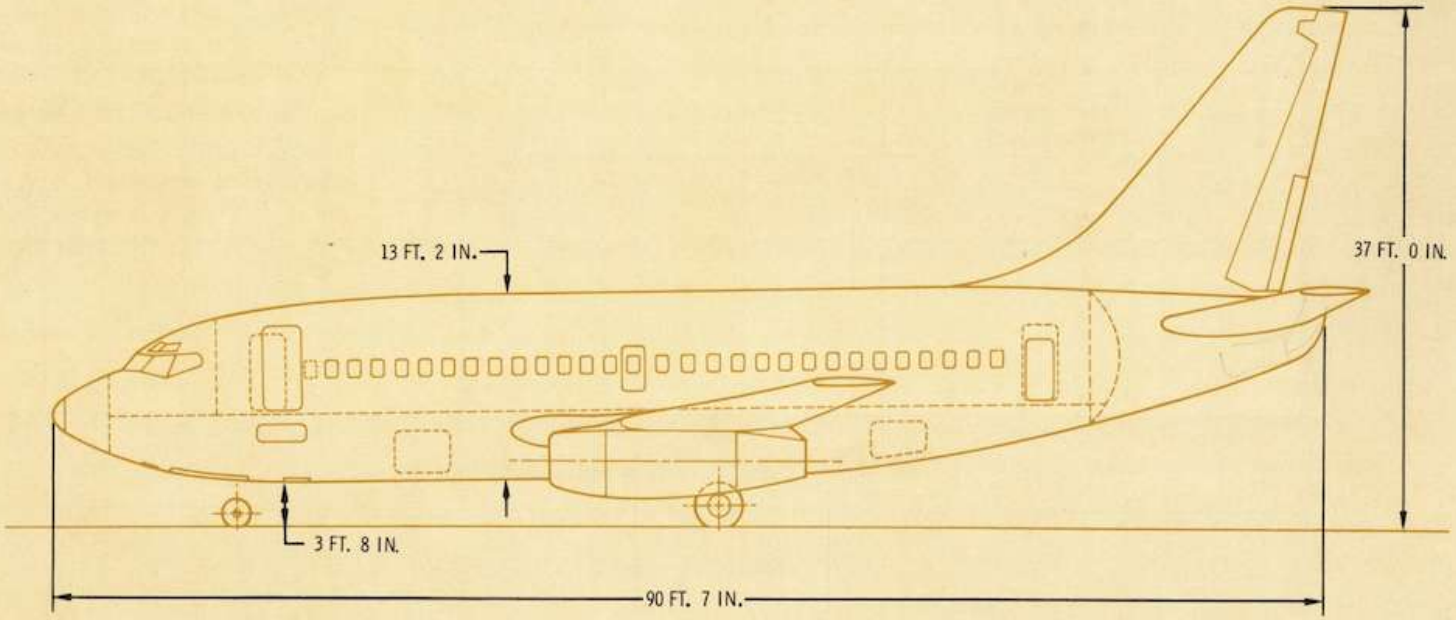
737-100 GENERAL ARRANGEMENT

Nominal design gross weight —lbs.	85,000
Max. flight gross weight—lbs.	93,500
Max. taxi gross weight—lbs.	94,100
Max. landing weight—lbs.	89,000
Max. zero fuel weight—lbs.	81,000
Oper. weight empty—lbs.	50,983
Power Plant—JT8D-1/JT8D-5	
Takeoff Thrust (SLST)—lbs.	14,000/12,000
Fuel Capacity—U. S. Gallons	
Standard	2850
Optional with one add'l cell	3425
Optional with two add'l cells	4000

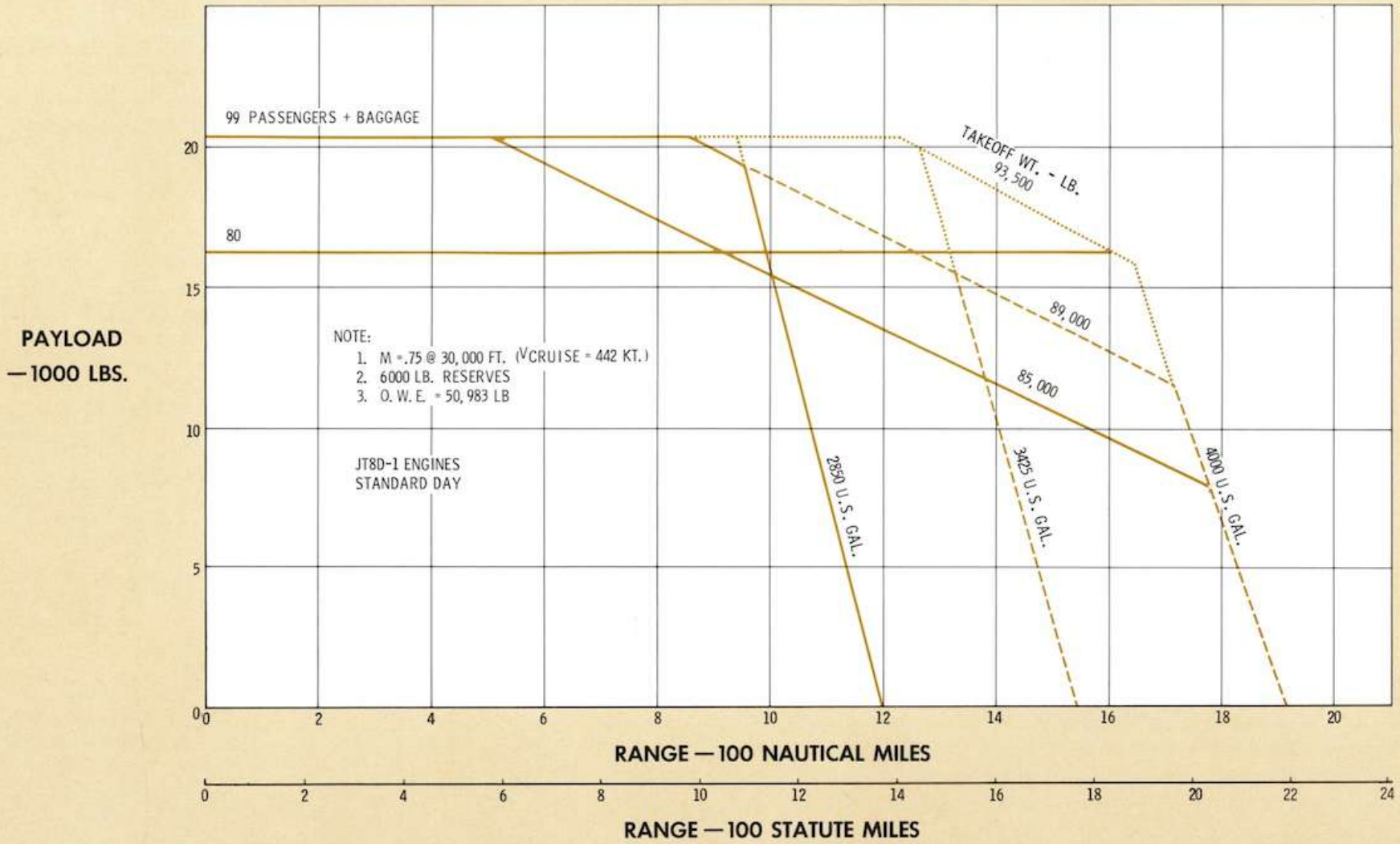





89 FT.
36 FT.
17 FT. 2 IN.


13 FT. 2 IN.
37 FT. 0 IN.
3 FT. 8 IN.
90 FT. 7 IN.

PAYLOAD RANGE 737-100



performance

PAYLOAD RANGE

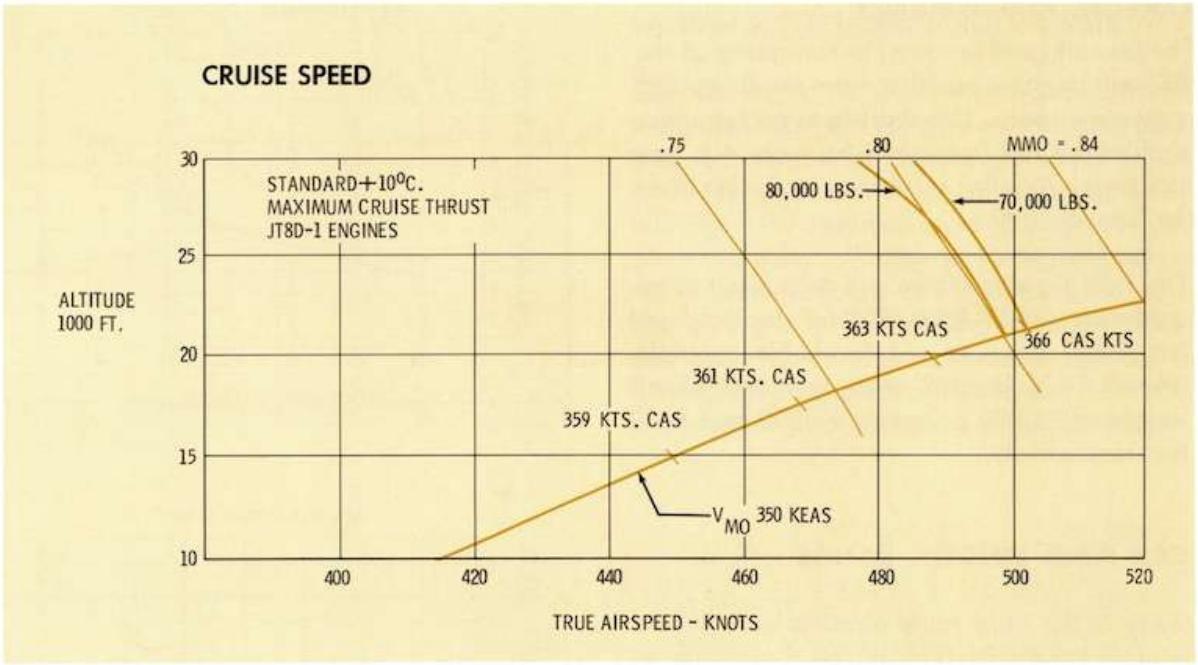
At Mach .75 and an altitude of 30,000 feet, the 737 carries 99 passengers and baggage 1000 statute miles; this assumes current allowable takeoff weights. After structural testing the range capability will increase to 1400 statute miles with a full payload.

The typical payload-range curve includes 8 minutes taxi fuel, 4 minutes air maneuver, and U.S. domestic reserves defined in CAM 40.396.

CRUISE SPEED

The 737 is capable of reaching its maximum operating airspeed limit (V_{MO}) of 350 knots equivalent airspeed (EAS) up to a cruise altitude of 22,000 feet (505 knots TAS).

Speed capability above 22,000 feet is defined by the maximum cruise thrust rating. Many of the 737 missions will be flown at altitudes below 22,000 feet where a high V_{MO} is important to low block time.



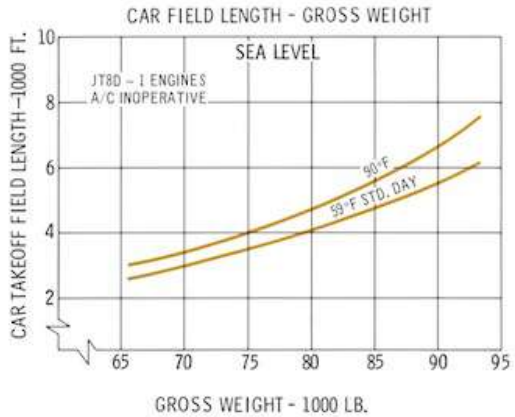
TAKEOFF PERFORMANCE

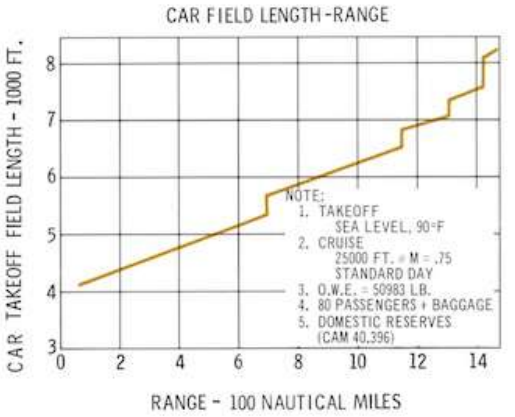
The takeoff (and landing) performance of the 737 will permit operation from small city and regional airports. This short-field performance enables the 737 to operate from airports now handling propeller airplanes no larger than the Convair 340.

The field lengths shown are calculated in accordance with CAR SR-422B for standard and hot (90°F) days, at sea level. For example, takeoff field lengths at a nominal takeoff weight of 85,000 pounds are 4800 and 5600 feet respectively.

CAR FIELD LENGTH—RANGE

Many of the short route airports have limited runway length. Because of this, passenger jet service to these airports has not been possible. Now, due to its takeoff and landing performance, the 737 offers profitable range potential from fields of 5000 feet or less. The curve shown is for a 16,000 pound payload (80 passengers and baggage), or an 80 percent load factor in an all-tourist cabin configuration.





LANDING PERFORMANCE

APPROACH SPEED

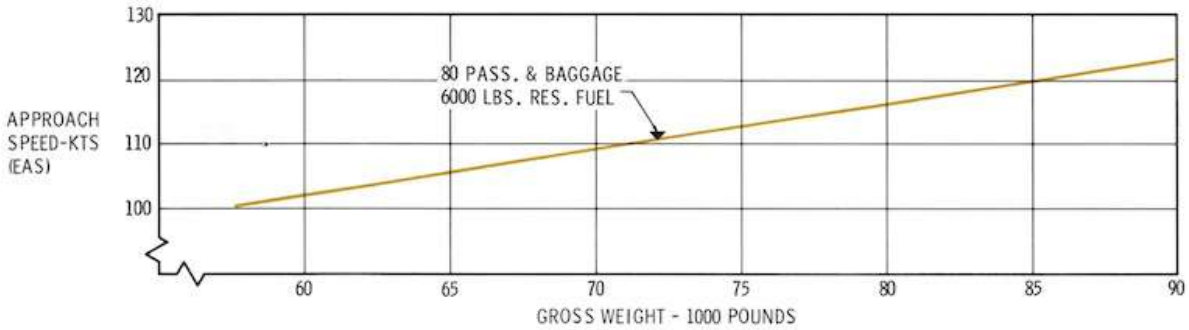
Without sacrifice to cruise drag and ride comfort the 737 achieves a significant reduction in approach speed. The high-lift system that makes this possible includes triple-slotted flaps and leading-edge slats and Krueger-type flaps. Because of the frequency of landing and takeoff in short route operation, low approach speed is an important characteristic. In the curve, speed is plotted against gross weight and an example shows that with a full passenger load (five abreast at 36-inch seat spacing) an approach speed of 111 knots is possible, increasing the margin of safety during landing.

LANDING FIELD LENGTH

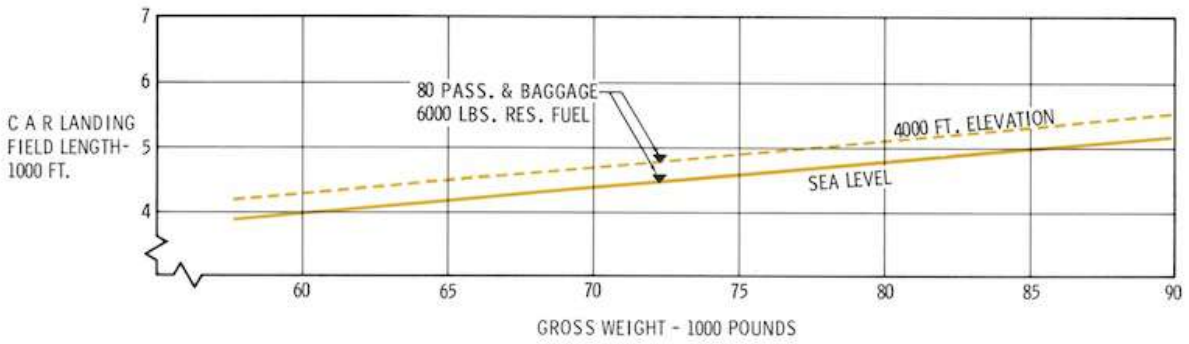
Low touchdown speed and the use of ground spoilers make possible the short field lengths shown in the curve. Low touchdown speeds, combined with the low takeoff speeds afforded by the flap system, result in thicker tire tread and greater tire and brake life. A typical landing field length of 4500 feet is shown for a full payload of 80 passengers and baggage.

LANDING PERFORMANCE

APPROACH SPEED

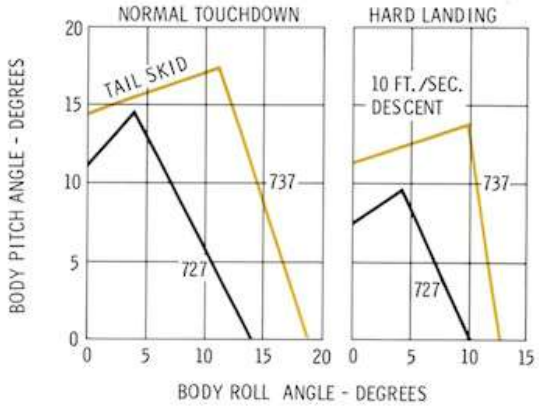


LANDING FIELD LENGTH



LANDING PITCH AND ROLL LIMITS

Contributing to the excellent landing performance of the 737 are the generous landing pitch and roll limits. At a maximum landing weight of 89,000 pounds and normal descent, the 737 will allow the operator up to 17 degrees body pitch at a body roll angle of 12 degrees before the airplane structure or engine nacelles touch the runway. If a hard landing is made (10 feet per second descent) these limits are reduced to 14 degrees body pitch at 10 degrees body roll; still providing added safety during landing.



COMMUNITY NOISE LEVEL

Takeoff and landing noise levels for the 737 compare favorably with those of other aircraft in the same class. The low jet exhaust velocity of the JT8D fan engine is partially responsible. The 737 and 727 are the world's only airplanes incorporating tuned inlet noise suppressors which virtually eliminate inlet "spikes."

LOWER WEATHER MINIMUM CAPABILITY

Equipment to satisfy proposed FAA Category II low weather minimum criteria is standard in the 737 as an outgrowth of Boeing's multi-million dollar development program on the 720 and 727 airplanes.

Flight control systems afford the optimum match between the pilot's capabilities, airplane handling characteristics, and the autopilot, allowing approaches and landings to be executed under adverse conditions with minimum effort, maximum precision and repeatability, and uncompromised safety.

The autopilot, an improvement over the 727, has been specially designed for ILS localizer and glide slope control. All components are derated. Solid-state switching is used in signal circuits, and close tolerances are maintained through use of high quality components and internal tolerance trim-out adjustments.

The 737 operates at the lowest approach speed of any jet transport and exhibits excellent speed stability. With these advantages, the time available for the pilot to acquire visual orientation and make flight path corrections during the transition from approach to touchdown is increased; a greater lateral misalignment correction during transition can be made; and runway length requirements are reduced.

The 737 is designed to fulfill FAA Category III-A criteria (when formulated) simply by the installation of units into space specifically allocated. This space will eliminate extensive modification, redesign, and rewiring when Category III-A equipment is certificated for routine use.

features

INBOARD PROFILE

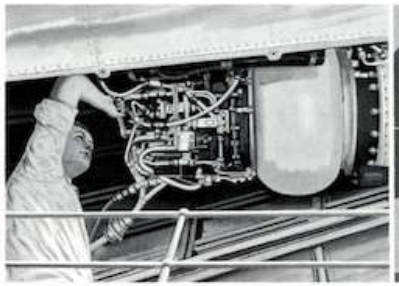
Passengers and crew board the 737 through a single forward entry door on the left side. A full-size aft entry door with or without the integral stair is available as an option. All entry and service doors are of plug-type design. Two emergency exit doors are centrally positioned in the passenger compartment with access to the wing. In combination with service and entry doors at each end these emergency exits provide more than adequate escape egress.

Airstairs carried directly under the forward entry door eliminate the need for airport stairways. The airstairs are stowed underneath the cabin floor and the airstair aperture is sealed by a plug-type door.

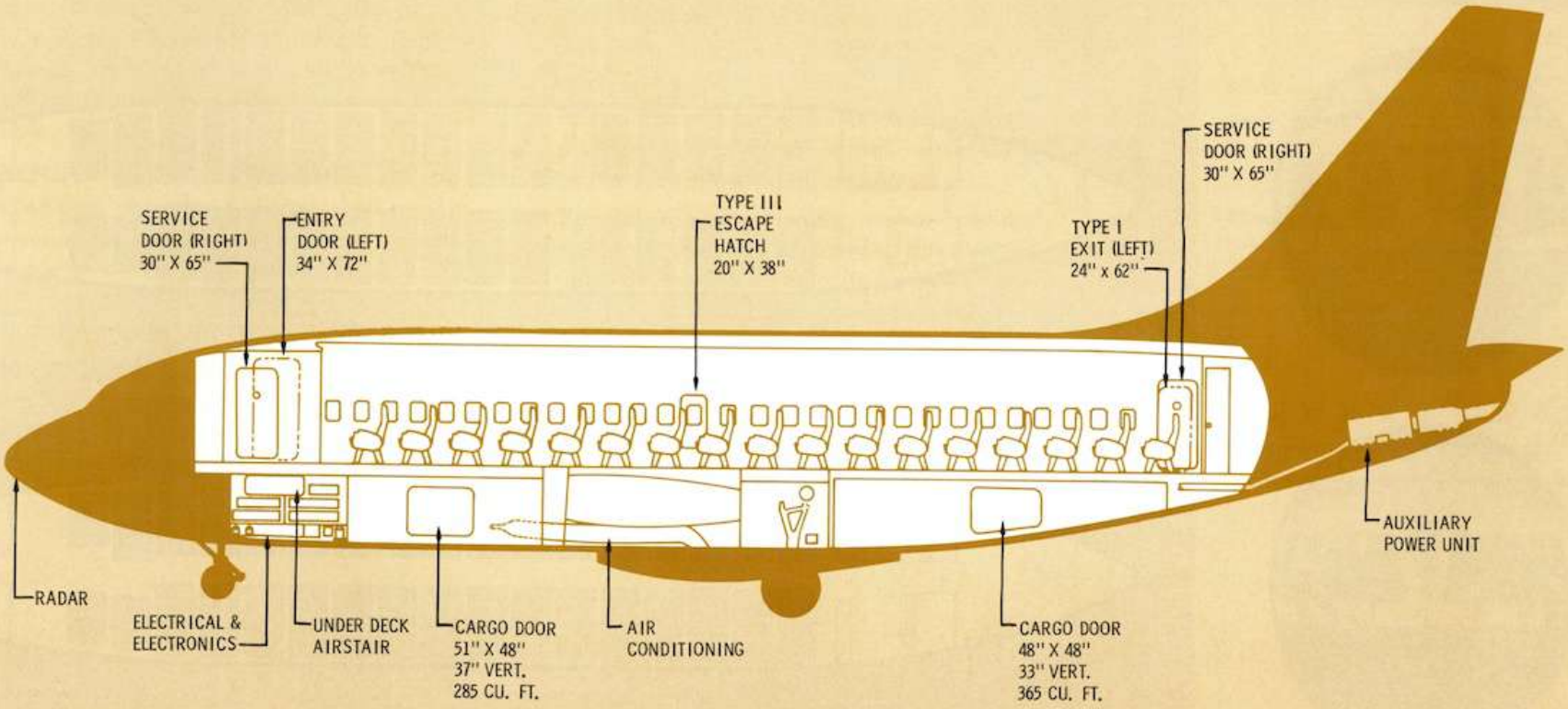
Six hundred and fifty cubic feet of cargo space are packaged in two compartments, one forward and one aft of the wing. Access to each of these areas is through large cargo doors opening on the right side.

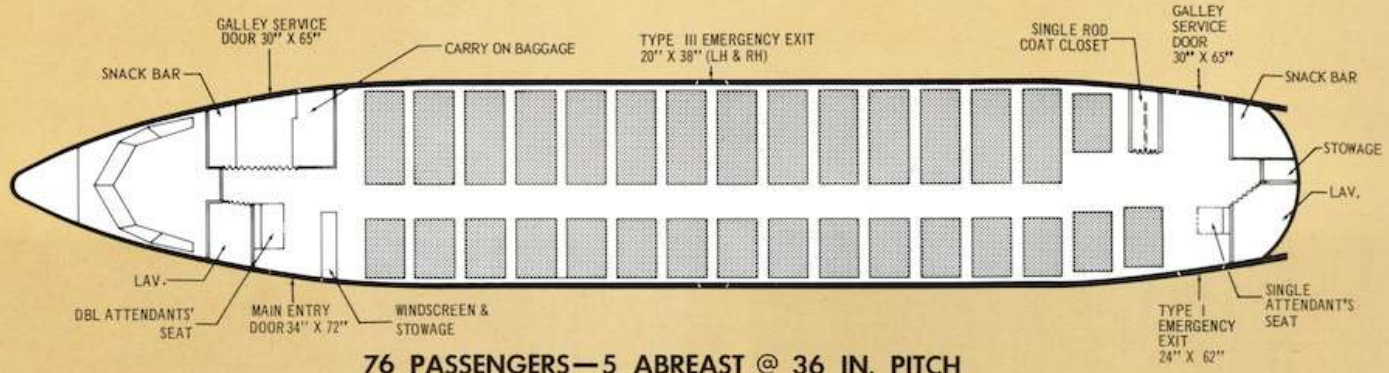
Immediately ahead of the forward cargo compartment is the electrical and electronics equipment bay. Cooling, as required, of shelf-mounted electronics packages is provided by blower. Air-conditioning packs, accessible through large access doors, are centrally located forward of the main landing gear.

The auxiliary power unit (APU) with built-in sound suppressors installed in the tail end of the fuselage supplies electrical energy and air for engine starting and air conditioning on the ground. In flight, the APU provides air-conditioning air or electrical power in the event of an engine shutdown. With electrical power, hydraulic power is also available from electrically driven pumps.

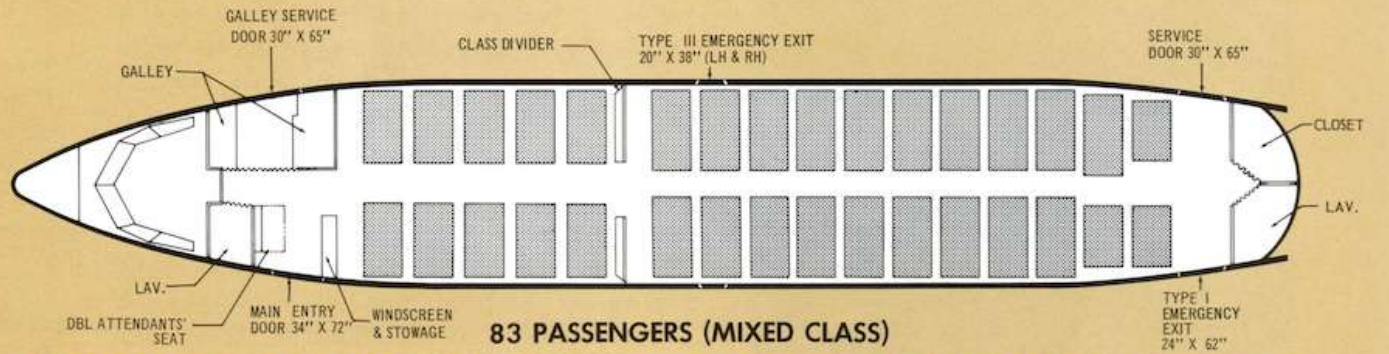


INBOARD PROFILE



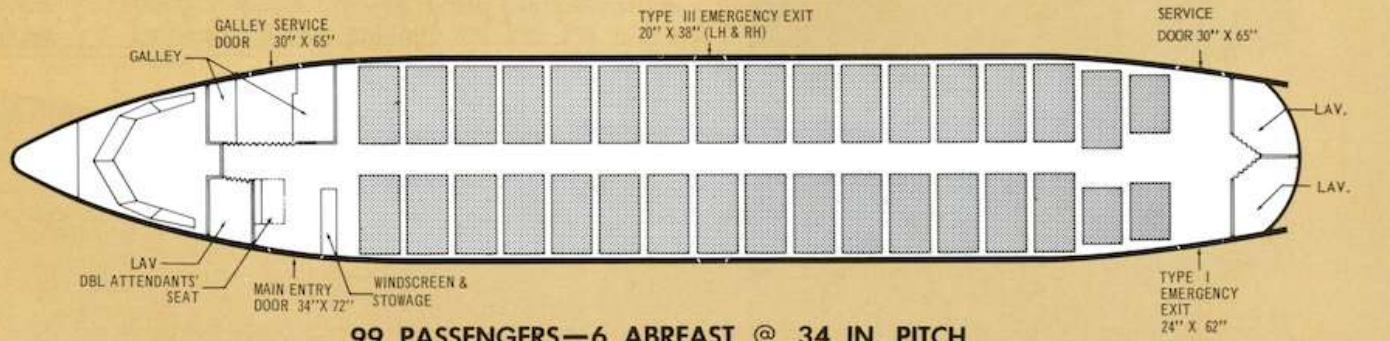


76 PASSENGERS—5 ABREAST @ 36 IN. PITCH



83 PASSENGERS (MIXED CLASS)

20 PASSENGERS—4 ABREAST @ 36 IN. PITCH 63 PASSENGERS—6 ABREAST @ 34 IN. PITCH



99 PASSENGERS—6 ABREAST @ 34 IN. PITCH

WIDE BODY

PLAN VIEW OF SEATING ARRANGEMENT
Designed to carry 76 to 99 passengers the basic 737 interior offers familiar space and comfort to the traveling public. The unmatched seating flexibility afforded by the large diameter fuselage and track-mounted seats is normally found only in large jet liners. High density versions of 103 passengers are feasible.

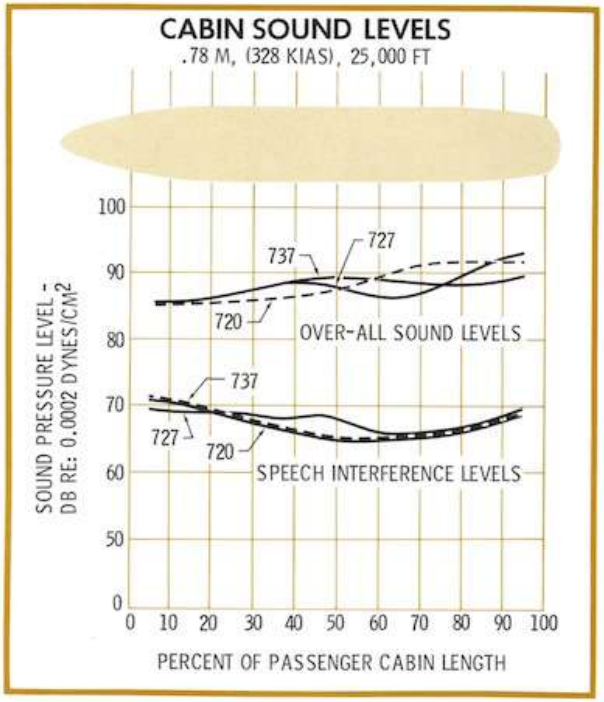
PASSENGER CABIN CROSS-SECTION

The 148-inch diameter fuselage shell permits a selection of 4-, 5-, or 6-abreast seating. Aisle widths of 18 to 28 inches combine with a generous 86.30-inch headroom to provide adequate walkway space.

CABIN SOUND LEVELS

During 707/720 development and design, exhaustive studies isolated and identified the sources and characteristics of cabin sounds. The results of these studies, together with experience gained with the 727, provide an unparalleled basis for controlling interior noise. 737 cabin sound levels are reduced to a minimum through use of:

- Acoustical insulation blanket in sidewalls and ceiling.
- Panels that use the Helmholtz resonator principle to absorb rather than reflect much of the sound impinging on sidewalls.
- Special air-conditioning system components, which minimize sound effects through valve design and air velocity control. Equipment location and acoustically treated ducts further minimize air conducted noise.
- Vibration mounts that isolate engine and other equipment noise from the cabin.
- Special techniques to reduce sound leaks through insulation material.



FURNISHINGS AND EQUIPMENT

Basic 737 cabin layouts position a complete double hot-meal galley opposite the main entry door. Galley servicing is accomplished through a right service door to eliminate interference with passenger traffic. A cabin attendent seat folds down from the aft wall of the forward coat closet.

Passenger service units, located below the hatracks, provide all necessary information displays, loudspeakers, passenger oxygen masks, and auxiliary cabin air (gasper). Out-of-line placement of this passenger service unit allows easy entry to window seats regardless of seat pitch.

737 interior furnishings have been carefully selected to reduce spares inventories; particularly for airlines already operating other Boeing jetliners.

Maintainability and fit of the furnishings are assured by a multimillion dollar tooling and development program that continues the 707/720/727 design for 737 airplanes. The interior furnishings are the end result of a careful plan to provide maximum passenger comfort and safety.

INTERIOR ARRANGEMENT FLEXIBILITY

The basic wing-mounted engine configuration permits doors at all four corners of the cabin. The galley can be forward or aft. Two toilets can be located aft or one aft and one forward. In two-class versions, the class divider can be placed at any position. All interior furnishings, including seats, partitions, coat closets, and passenger service units, are mounted on tracks on the floor and/or hatrack.

COMPARISON OF CROSS-SECTIONS

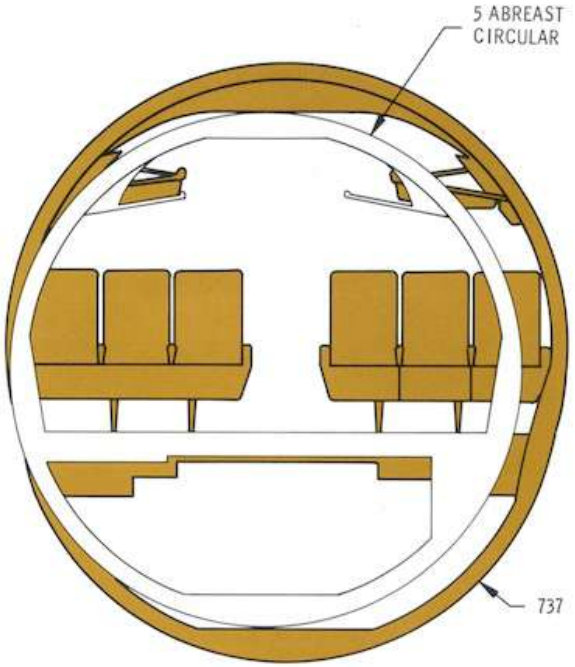
Comparisons of three different design philoso phies—a 5-abreast circular body, a 5-abreast double lobe, and the 737 6-abreast double lobe are shown in the cross-section illustrations. The wide body provides big-jet passenger environment and comfort plus the greater earning capacity of 6-abreast seating. The double-lobe concept achieves elbow and shoulder clearance for the window seat, excellent entry room and head clearance for all seats, a high ceiling over the aisle and hatracks, and wide, deep cargo and equipment compartments under the cabin floor.

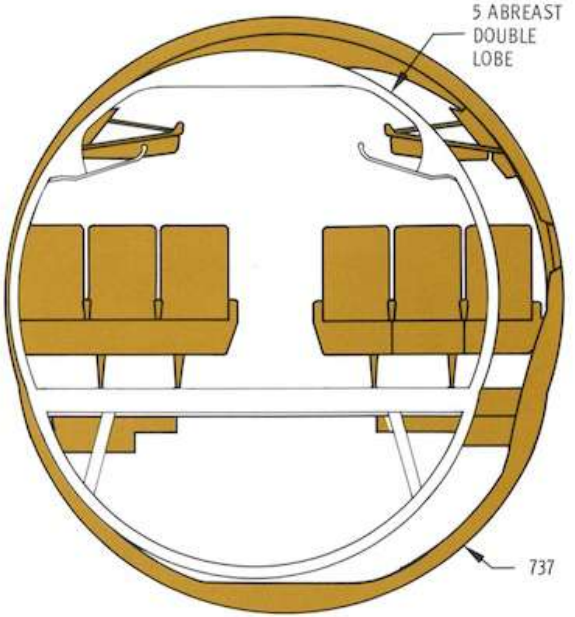
The 737 cross section is identical to the 727 forward constant section thus providing compatibility in interior equipment and furnishings with all Boeing jet transports.

The narrow circular body design results in a cramped passenger cabin when the floor is placed high enough to provide minimum cargo and equipment space under the cabin floor. The alternative narrow body using the double-lobe design is a compromise between overhead clearance in the passenger cabin and space under the floor.

The 737 wide body provides a passenger capacity increase of more than 15 percent in a fixed-length cabin with only a 1½ percent increase in drag and little more than 500 pounds added fuselage structure weight. Direct operating costs are increased less than one-half of one percent.

Installation of a 5-abreast seating arrangement in a cabin capable of 6-abreast seating provides a roominess unmatched in smaller aircraft.





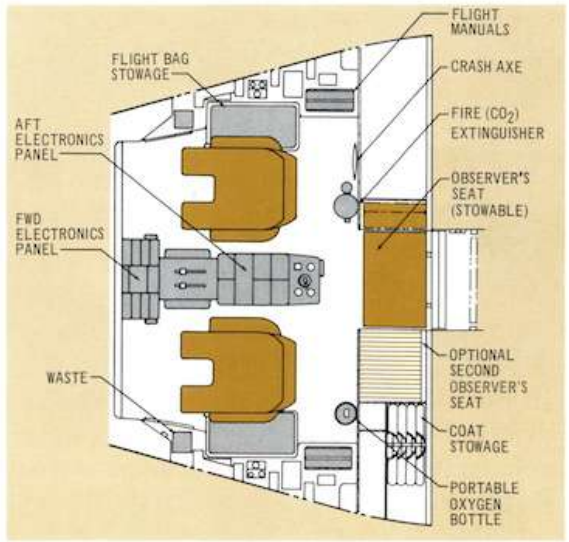
CONTROL CABIN

Simplicity keynotes the control cabin arrangement. The airplane is designed for two-pilot operation but can be flown by one pilot from either seat. Instruments and controls are readily accessible to Captain and First Officer. Instruments in the 737 control cabin are either identical or similar to those in the 727 with the exception of approximately ten new instruments. Panel controls are arranged to provide a minimum work load with panel controls that must be operated most frequently located closest to the crew member.

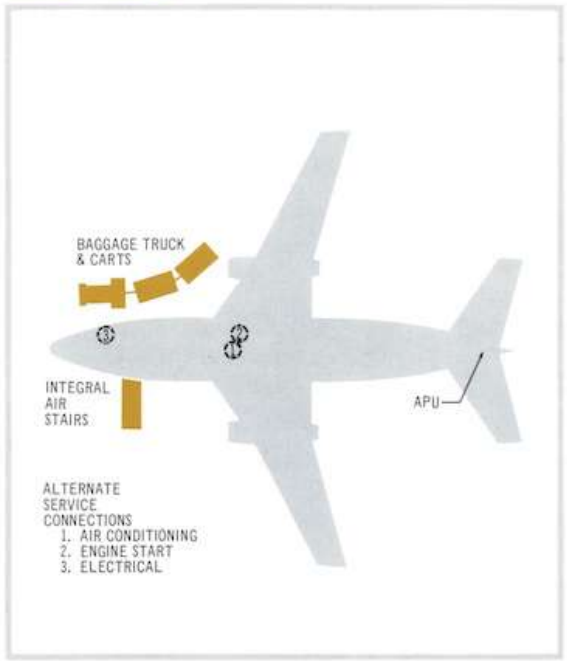
Controls are located between the pilots, as are certain electronics panels and the radar panel. Flight crews of other Boeing jets will feel right at home, since the popular control cabin flight controls concept and arrangement of the 727/720/707 has been retained in the 737. Similarity to the 727 is carried through to the forward instrument panels, glare shield, and overhead instrument panels.

Equipment shields containing circuit breakers and radio busses are located directly behind the pilots' seats as are oxygen and CO_2 fire extinguisher bottles.

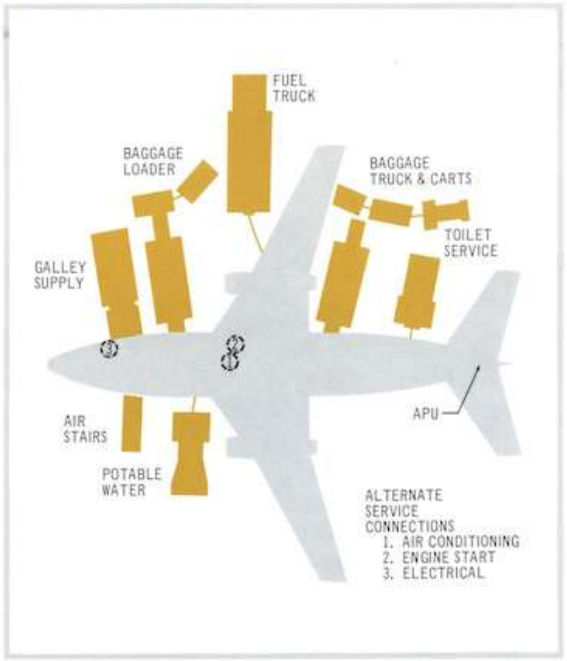
A stowable observer's seat, installed in the aisleway, folds out of the right equipment shield. An optional second observers seat can be located behind the Captain.



THRU — STOP



TURNAROUND



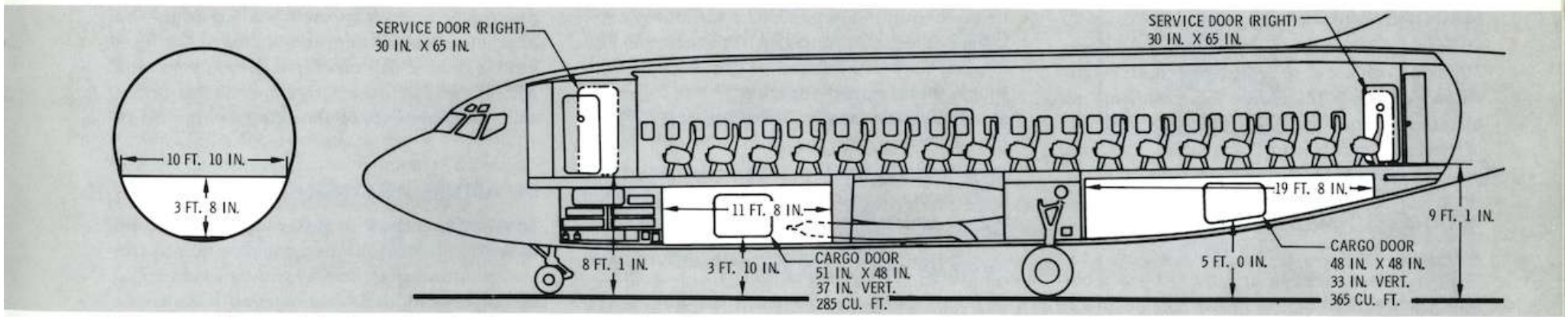
GROUND SERVICING

A principal reason for the 737's low operating cost is its unusually short servicing time.

The 737 has been designed for maximum freedom from ground support equipment and servicing units. The APU, started by the aircraft battery, supplies power for air conditioning (cooling and heating) on the ground, engine starting, and electrical power for lights, radio, and other instruments. The 737 also incorporates its own passenger loading and unloading "airstair," thus eliminating the need for airport ground facilities.

Normally, the airstair is electrically powered. However, in the remote event that power failure occurs, the airstair may be operated manually.

The only service required for a minor thru-stop is baggage handling. Average minor thru-stop ground time from "airplane-parked" to "ready-to-taxi" is estimated at 11 minutes. No ground equipment except baggage carts is required at minor thru-stops.



Galley servicing and fueling at major thru-stops do not interfere with passenger movement and cargo handling. Average ground time is 18 minutes.

Two easily accessible water connections are located within easy reach of the ground. Potable water and toilet facilities are designed to require minimum servicing.

CARGO AND BAGGAGE HANDLING

The deep cargo compartments permit efficient cargo handling. Large doors are only 46 inches above the ground to simplify loading and unloading by hand or conveyor belt.

Carry-on baggage racks, similar to those of the 707, 720, and 727 models, may be installed by using overhead and seat track attachments.

SERVICE DOOR ARRANGEMENT

Service doors are confined to the right side of the fuselage. The galley door location, opposite the main entry door, reduces ground time because food service for both the first class and tourist sections can be loaded separately from the passenger entrance.

HIGH DESIGN LANDING WEIGHT

The 737's design landing weight of 89,000 pounds eliminates the unnecessary expense of fueling at frequent intervals to reduce ground time at thru-stops.

MAINTAINABILITY

Maintainability successes achieved with the 727 are reflected in adaptions and refinements for the 737. Other improvements realized may make the 737—from the standpoint of normal small airport operation—the most easily maintained airplane yet built.

"EYE LEVEL" MAINTENANCE

A unique characteristic of the 737 is its "eye level" maintenance features. Nearly all maintenance requirements may be carried out at ground level without ladders, hoists, or other high lift devices. This means that the operator will not be burdened by the necessity of providing additional above-the-ground service equipment.

ENGINE MAINTENANCE

The wing-mounted JT8D engines eliminate the need for high lift engine change equipment. Unlike other short range jet transports, the 737 engines may be changed at ground level with simple hand-hoists attached to the airplane structure. Side beams, designed for 727 engine changes, may be used with only minor modifications. Small airport equipment, presently in use, is all that's necessary for normal engine maintenance.

SYSTEMS MAINTAINABILITY

Major systems are grouped at readily accessible locations for easy maintenance. Hydraulic units are located in the main wheel wells readily accessible for a mechanic standing on the ramp. Air-conditioning units under the wing are accessible through large doors. Electronics equipment is stored in racks in a bay aft of the nose wheel well. Major control system components in the wing are accessible through leading-edge and trailing-edge flap openings. The APU in the tail end of the fuselage is cowled like an engine. The gas turbine APU and all its accessories are readily accessible for maintenance through cowl openings.

DEPARTURE RELIABILITY

That low maintenance costs result in decreased operating expense should come as no surprise to the operator of Boeing airplanes. The 700 series jet transports have enjoyed historic success in this area. Each succeeding model, from the 707-120 through the 727, has shown a marked increase in maintainability, and more significantly still, in dispatch reliability. The 707/720 series achieved reliabilities of 97 percent. The 727 has achieved a departure reliability of 98 percent. The 737 predicted departure reliability is 99 percent.

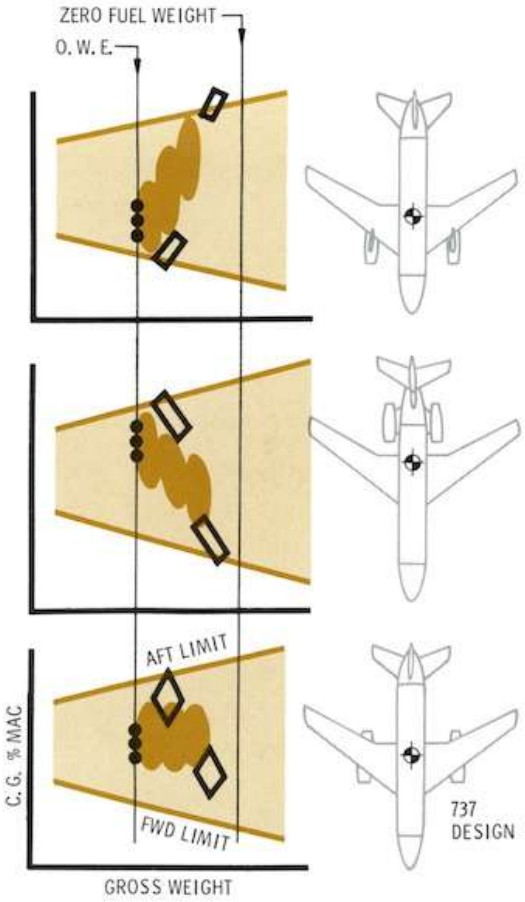
Boeing criteria for evaluating dispatch reliability include all mechanical delays. In addition, Boeing conservatively counts all delays over 5 minutes in contrast to the normal industry standard of counting delays over 15 minutes. The 99 percent dispatch reliability forecast is based on the 5-minute criterion.

The steady improvement in reliability is the result of a combination of Boeing experience which now reflects many different customers' suggestions and a continuous service organization effort to improve reliability and to decrease maintenance costs. These things, coupled with a careful attention to forecasting detail, indicate a dispatch reliability of 99 percent for the 737.

LOADABILITY

The diagram illustrates the balance flexibility of the wing-mounted engine configuration. The center of gravity (CG) location (as a function of percent of mean aerodynamic chord) is plotted against gross weight. The curves on the chart represent passenger loading and the diamonds represent cargo loading.

Loadability is critical for small, modern high-performance aircraft. As shown on the diagram a small jet having engines mounted forward of the wing, results in an airplane having most of its loadable space well aft, resulting in a rearward movement of the CG with increasing gross weight. Aft-mounted engines cause the opposite result, with the CG moving forward with increasing gross weight. The 737 with wing-mounted engines has its payload centrally balanced on the wing, permitting optimum operator convenience.



BOEING 737
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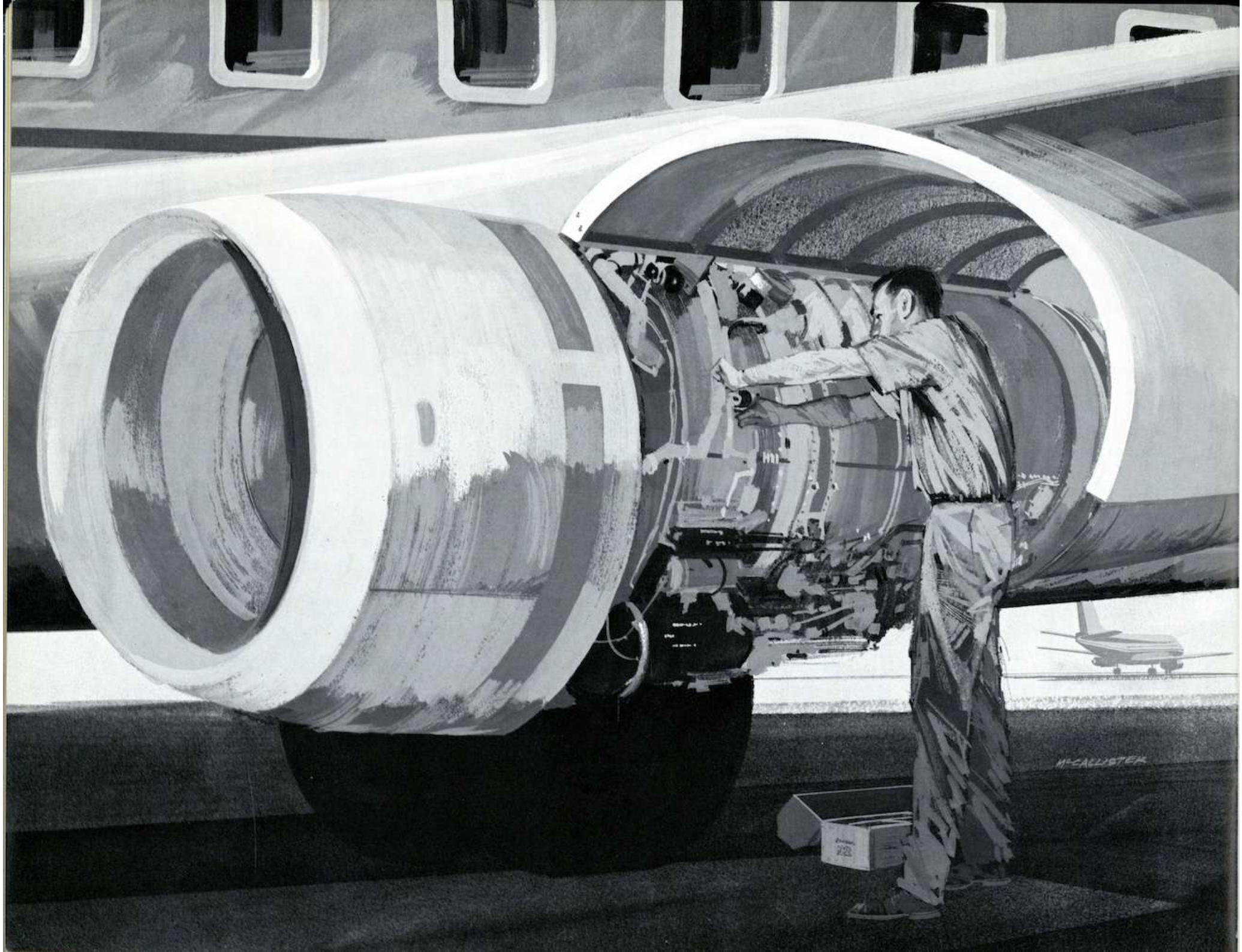
737/727 commonness

The 737 design draws heavily from its companion aircraft, the 727. Commonness between the two planes is apparent in the 737's wide body structure; identical doors, sidepanels, ceilings, seats, and engines.

Powerplant buildup commonness extends from the basic Pratt & Whitney engine to the low-oil-pressure switch. Components common to 727 and 737 powerplants include thrust reversers, nose cowl, starter, and valves. Commonness results in lower maintenance costs and reduced spares inventories.

The experience and technology of the previous jet transports are built into the 737. Test and maintenance facilities already established for the 727 (and 707) can be modified, if necessary, to aid in the servicing of the 737. When an airline already flying 727's adds the 737 to its fleet, a great savings in introductory costs will be realized. Spares investment will be lower; base, line, and flight training will be held to a minimum.

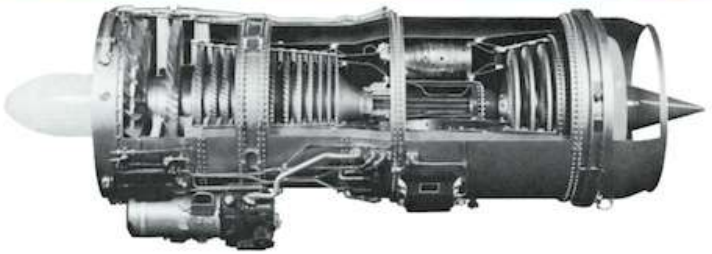
Commonness between the 737 and 727 was planned from the first. The same design team that produced the 727 produced the 737. They assigned compatibility as a design requirement. Commonness is a specification item; commonness by part number is documented; 737 commonness is guaranteed by Boeing. Commonness will be maintained even though "state-of-the-art" improvements will be made available on both 737 and 727 airplanes in the future.


McCALLISTER

systems

POWER PLANT

Two Pratt & Whitney JT8D turbofan engines, rated at either 12,000 or 14,000 pounds sea level static thrust, power the 737. The JT8D engine has a full length integral fan air duct. Bypass air, ducted within the outer case of the engine, provides heat isolation and a relatively low temperature environment for the engine accessory section. Fan air is mixed with the hot turbine discharge gases forward of the thrust reverser. Due to internal mixing of bypass air and hot gases, tailpipe exit velocities are low enough to preclude the need for external sound suppressor. Power plant and related systems have been designed so that failure of one engine will not affect operation of the other. The engines are mounted on the wing by three cone bolts—two in front and one in the rear.



STANDARD DAY CHARACTERISTICS		JT8D-1	JT8D-5
TAKEOFF THRUST	(S.L. STATIC)	14,000 LBS	12,000 LBS
	(S.L. 100 KTS)	12,630 LBS	10,850 LBS
CRUISE THRUST			
25,000 FT	(MC_R T @ M .800)	4685 LBS	4170 LBS
30,000 FT	(MC_R T @ M .800)	4080 LBS	3750 LBS
SPECIFIC FUEL CONSUMPTION	LB/HR/LB		
25,000 FT	(MC_R T @ M .800)	0.803	0.806
30,000 FT	(MC_R T @ M .800)	0.795	0.793
BYPASS RATIO	(S.L. STATIC, T.O. THRUST)	1.10	1.18
WEIGHT	(DRY ENGINE)	3,096 LBS	3,096 LBS

"Eye-level maintenance" is assured by wing-mounting the engines: cowl panels hinge at the top of the engine or detach so that most components are accessible without a stand. Six men can change a power plant in approximately one-half hour.

LANDING GEAR

All main landing gear parts are identical for left and right hand gear, thus cutting spares inventory in half. One actuator hydraulically drives the gear into both uplock and downlock positions. A manual extension system allows the gear to free-fall down and lock simply by releasing the uplock hook. The main landing gear wheel wells have no doors. The wheels in their retracted position form an effective wheel-well seal. This simple design allows easy access to hydraulic and control systems and eliminates doors, door sequence valves, two actuators, and a fail-safe manual door opening control system.

The nose gear installation includes one-piece doors, and a common up and down lock. The gear retracts forward, and in case of hydraulic power failure, free-falls to the down and locked position. Towing is possible to a turning angle of ±80 degrees before torque link disconnection or other ground crew operations are necessary.

Footprint pressure of the gear and tires as represented by load classification number (LCN) indicates that the 737 presents no problem to airports currently used by 4-engine propeller transports. For operators requiring even lower footprint pressures, extra large tires are available as an option.

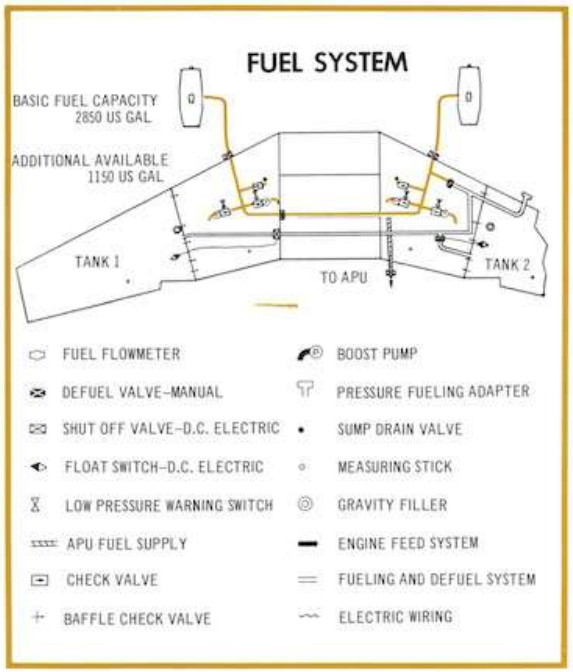
OXYGEN SYSTEM

The 737 has two gaseous, high pressure oxygen systems: a crew system and a passenger system. Portable oxygen breathing bottles are provided for emergency and first aid use. Oxygen for the cabin attendants is available from the passenger system. The systems are replenished at a common external connection.

The passenger oxygen system becomes operative when the cabin pressure falls to 14,000 feet altitude. An aneroid-operated device, part of the continuous flow control unit, senses cabin pressure continuously and automatically starts the flow of oxygen when required. The system can also be actuated electrically by a switch on the pilots overhead panel.

WATER SYSTEM

The passenger water system, using a single storage tank mounted below deck, supplies potable water under pressure to the lavatories and galley. A pressure of 25 psi is maintained in the tank from the air-conditioning supply duct. Ground and standby pressure is supplied by the auxiliary power unit. The system is filled and drained in the conventional manner at an external service panel.



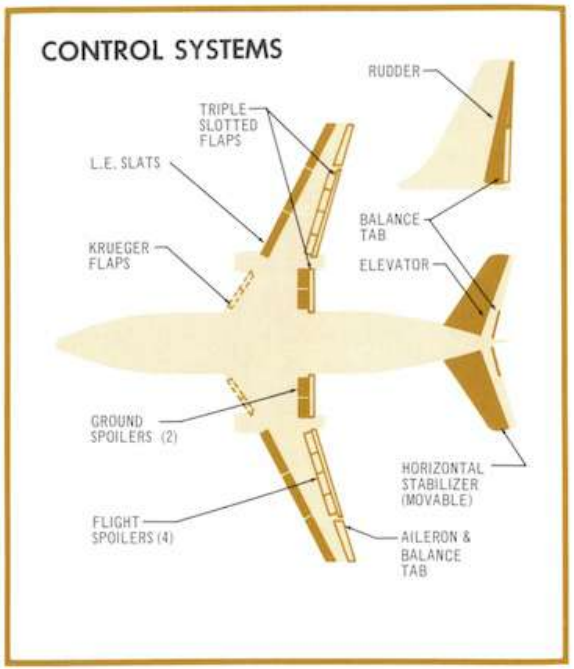
FUEL SYSTEM

The 737 uses a two-tank fuel system. Fueled at 300 gallons per minute through one adaptor, 2850 gallons can be pumped into the tanks in less than 10 minutes. Additional cells can be added to the airplane, increasing fuel capacity to 3425 or 4000 gallons.

Fuel lines are contained within the tanks. The 737's landing weight is so close to its takeoff weight that an emergency dumping system is unnecessary. Fuel system valves and pumps can be replaced without draining fuel tanks.

CONTROL SYSTEMS

Flight control about all three axes is fully powered by hydraulic servos with automatic manual backup. Pilot "feel" is supplied artificially, establishing gradients which satisfy



a rigid FAA and pilot standard of acceptability. Integration of flight control and automatic pilot is made by applying the autopilot signals through to the same power control units which are used during pilot controlled flight. The control system is a simplifed version of the 727 system assuring that the 737, like its larger running mate, is a "pilots' airplane."

High-lift devices are a combination of leading-edge slats outboard of the nacelle and slotted Krueger flaps inboard of the nacelle and trailing-edge triple-slotted flaps. Lateral control is achieved by a single aileron and spoilers on each side. The outboard four panels are both speed brakes in the air and lateral control devices. The inboard two panels are ground spoilers which are operated on landing and do not come up when the airbrakes are used in the air. If all hydraulic power is lost, the airplane can be flown manually — directly coupled to the control surfaces. Reversion to manual control is automatic upon loss of the second hydraulic system.

The effects of asymmetrical thrust have been minimized by design of the fin and rudder.

AIR SYSTEMS

Pressurized bleed air drawn directly from the 8th and 13th stages of the engine compressor section is the basic air source for cabin air conditioning (heating, cooling, ventilating), cabin pressurization, and engine cross-starting. Airflow is also available from the compressor section of an on-board gas turbine APU. The APU provides self sufficient engine starting and air conditioning on the ground and is operable in flight to supply electrical

power and limited air conditioning. Either of the two air-conditioning packs operating on air supplied by the APU will maintain full passenger comfort.

Engine bleed air is supplied from the 8th compressor stage for most operations. For conditions where 8th stage pressure is insufficient to meet system demand, automatic transfer to the final stage (13th) is effected. The cabin airflow is controlled to provide ventilation throughout the airplane operating regime and to maintain a prescribed pressurization schedule. A maximum cabin pressure differential of 7.5 psi provides sea level cabin pressure to 18,500 feet airplane altitude.

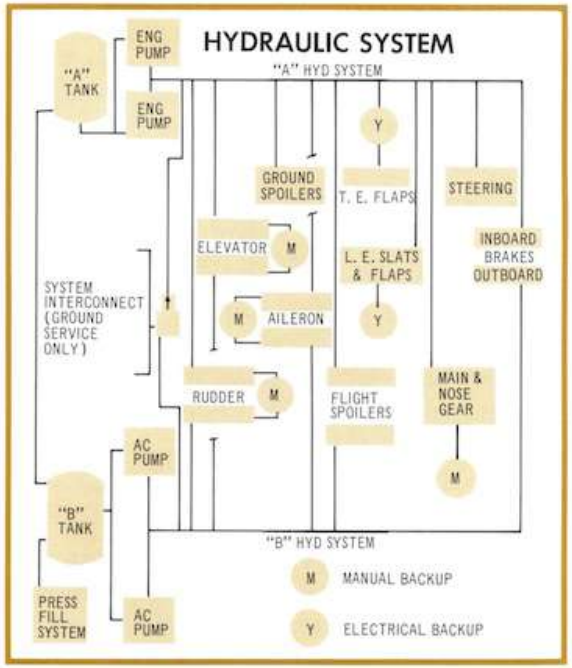
HYDRAULIC SYSTEM

The hydraulic system is divided into two functionally independent 3000 psi systems designated "A" and "B." Skydrol 500A fluid is used for maximum protection against fire.

System "A" is powered by two engine driven pumps. It provides hydraulic power for flight controls, ground spoilers, landing gear extension and retraction, trailing and leading-edge flaps, slats, nose-gear steering, and brakes.

System "B" is powered by two electric motor driven pumps, supplying power to flight controls and brakes. These pumps may also be used for ground steering.

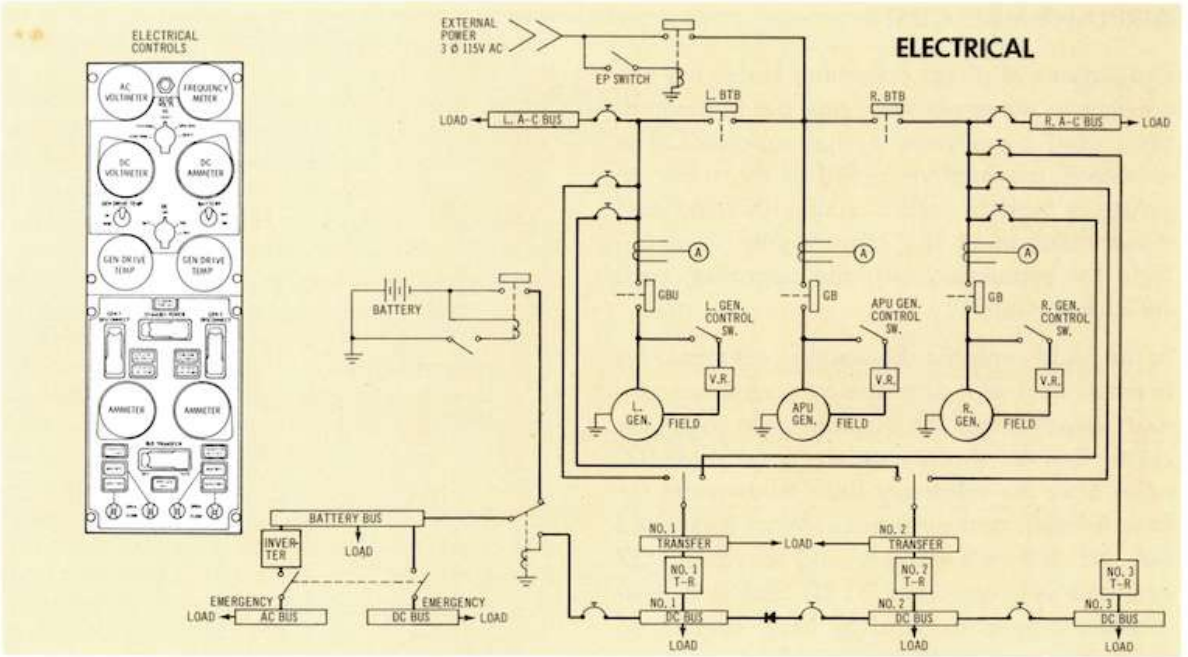
Systems "A" and "B" provide dual flight control systems and dual brake systems. Shutoff capability is provided for the "A" and "B" power flight controls and the flight spoiler system to permit isolation of these subsystems for training, malfunctions, or servicing.



ELECTRICAL AND ELECTRONICS

Logically grouped system components and wiring on removable shelves simplify maintenance and reduce training requirements. The two main ac load busses are energized by two isolated generators driven at constant speed. In the event of a generator failure, selected loads carried by that generator are relayed automatically to the other running generator. The APU driven generator serves as a ground source and, if needed, as an in- flight backup power source for the main generators.

Major components are removable as a group for overhaul or modification without disturbing other systems. Check-out test receptacles, terminal strips, test jacks, and annunciators are located on the shelves, on equipment shields, and on panels. Separation of the systems minimizes radio noise.



economics

AIRPLANE-MILE COSTS

Evaluations of direct operating costs vary according to the experience and detail assumptions used by airlines in their analyses. The economic assumptions noted in the table on page 36 tend to reflect a simplification and generalization of the most widely used criteria for evaluating airplane operating costs for comparison.

In the highly volatile short-range air transport market, cost per airplane-mile assumes primary importance. The airplane-mile costs (see curve) breaks sharply between 50 and 100 miles after the relatively fixed allowances for taxi, takeoff, and air maneuver are averaged out. At 300-mile ranges and beyond, 737 airplane-mile costs are $1.00 and less. Low airplane-mile costs tend to keep breakeven points low and profit potential high.

SEAT-MILE COSTS

Boeing's 737 offers the industry's lowest cost per available seat-mile for the short-range market. These competitive seat-mile costs result directly from two design decisions—1) low airplane-mile costs and—2) a cabin cross-section that provides both 5- and 6-abreast seating. Seat-mile costs for the basic 737 airplane are shown in the curve for 80 and 99 passengers. Combinations of mixed-class seating, possibly with some 4-abreast first-class seating sections, would displace the curves from those shown. However, the available seat-mile costs shown for 99 passengers, of less than one cent per seat-mile at ranges as short as 350 miles, offer a major competitive advantage for airlines operating over high-density, short-range routes when compared with airplanes limited to 5-abreast seating arrangements.

ECONOMIC ASSUMPTIONS

PERFORMANCE

FUEL AND TIME ALLOWANCE FOR TAXI, TAKEOFF, ACCELERATION, AND AIR MANEUVER

DISTANCE ALLOWANCE FOR ACCELERATION AND DECELERATION

FUEL RESERVES TO PROVIDE 45 MINUTES ADDITIONAL CRUISE. DIVERT 150 ST. MI. TO ALTERNATE, INCLUDING CLIMB FROM THE DESTINATION AIRPORT, CRUISE (LRC @ 24,000), AND DESCENT.

ECONOMICS

ATA COST METHOD (MODIFIED)

FUEL PRICE - 10 CENTS PER U.S. GAL.
TIME BETWEEN ENGINE OVERHAULS — 3000 HOURS
12 YR. DEPRECIATION TO 15% RESIDUAL VALUE
3000 HR. UTILIZATION PER YEAR
2 MAN CREW
9 MIN. BLOCK TIME MANEUVER ALLOWANCE

1.03 NON-REVENUE FLYING FACTOR INCLUDED IN FUEL, OIL, AND MAINTENANCE.

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